



# Armed Forces College of Medicine AFCM



# **Nutritionally essential vitamins 2 (B5,Biotin ,vitamin C, vitamin E)**

By  
**Dr. Naglaa Fathy, MD**



# INTENDED LEARNING OBJECTIVES (ILO)



By the end of this lecture the student will be able to:

1. List dietary sources of nutritionally essential vitamins (B5, Biotin, vitamin C, vitamin E, B15, B16)
2. Discuss functions of these vitamins (B5, Biotin, vitamin C, vitamin E, B15, B16)
3. Correlate clinical disorders to vitamin deficiency (B5, Biotin, vitamin C, vitamin E).

# Contents:



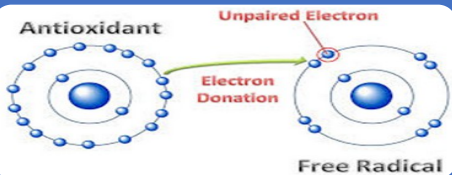
Pantothenic acid (vitamin B5)



Biotin (B7)



vitamin C



vitamin E



Newly discovered vitamins  
(B15, B16)



# Pantothenic acid (vitamin B5)

# Pantothenic acid (vitamin B5)



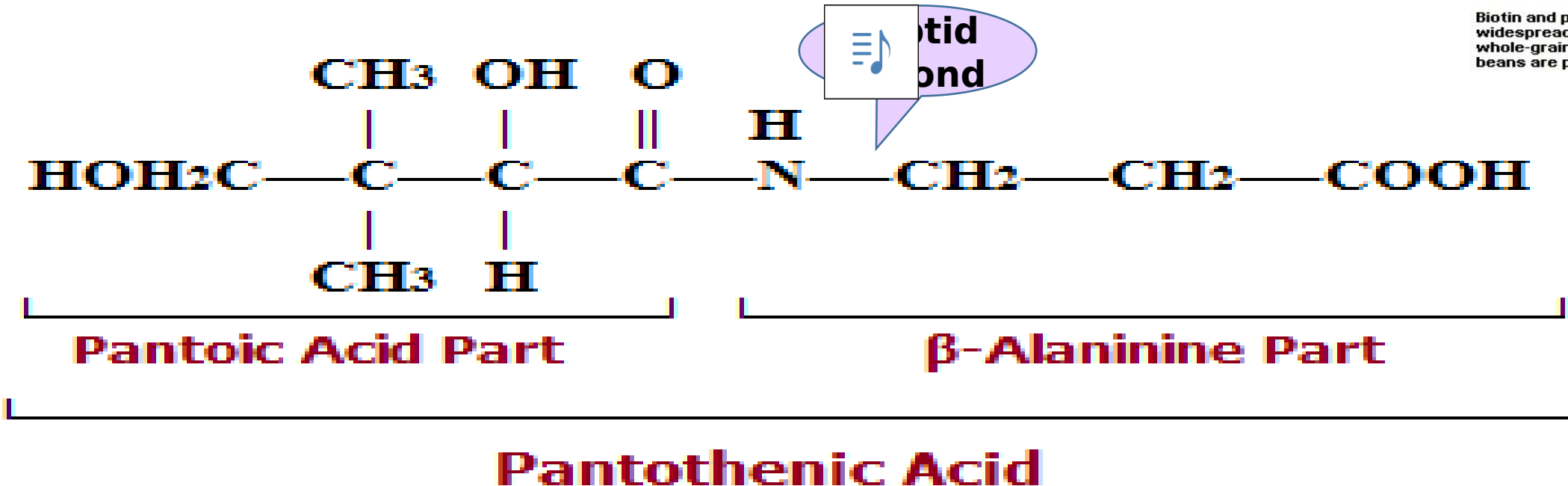
Pantos means 'everywhere' It is widely distributed in all food sources

Eggs, liver, and yeast are the most important sources

It is also synthesized by intestinal bacteria.

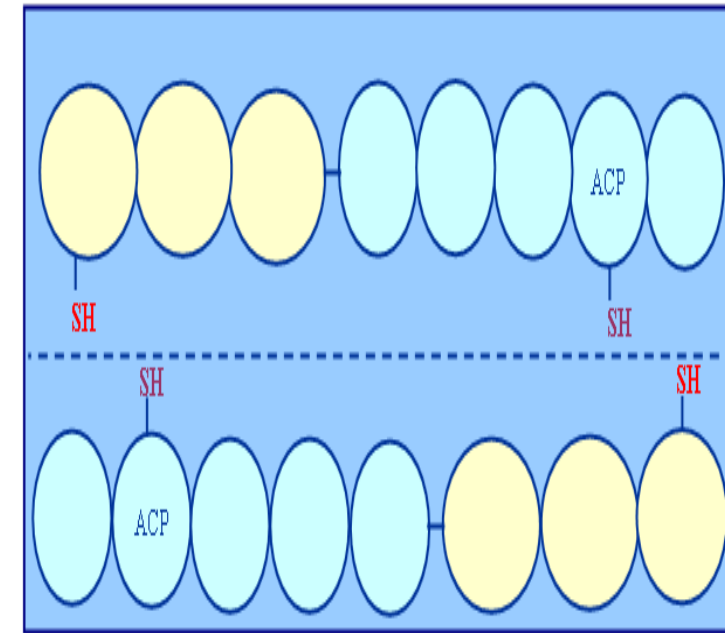


Biotin and pantothenic acid are widespread in foods. Meat, poultry, whole-grain cereals, broccoli, and beans are particularly good sources.

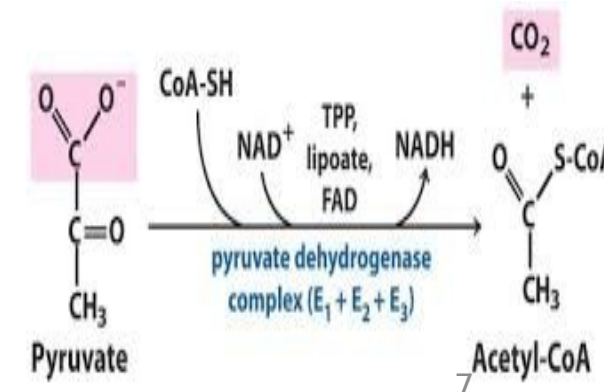


# Functions of Pantothenic acid (vitamin B5)

- 1-It acts as acyl carrier protein (ACP) in Fatty acid synthase system
- 2- vitamin B5 contain CoA-SH (the SH is the active group of CoA)
  - a. Fatty acyl-CoA ( $R-CO \sim S-CoA$ ) e.g. activation of fatty acids.
  - b. Acetyl-CoA or active acetate: formed during oxidation of carbohydrates, fats and proteins
  - c. Malonyl-CoA is used for fatty acid synthesis
  - d. Succinyl-CoA which may be oxidized through TCA cycle or used in ketolysis or heme synthesis
  - e. Oxidative decarboxylation of  $\alpha$ - keto acids e.g. PDH



**Fatty Acid Synthase  
Multienzyme Complex**



# Functions of Pantothenic acid (vitamin B5)



- Since pantothenic acid plays an important role in fatty acid synthesis and oxidation, so it is considered as a lipotropic factor



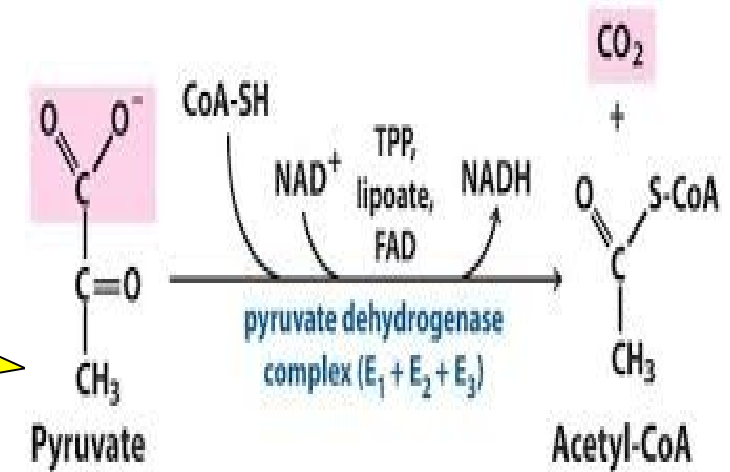
www.shutterstock.com · 521214682



**Lipotropic factors are substances which facilitate mobilization of fat and prevent accumulation of fat in liver**

***Oxidative decarboxylation of  $\alpha$ -keto acids*** forms a three-member family e.g.

1. pyruvate dehydrogenase
2.  $\alpha$ -Ketoglutarate dehydrogenase
3. branched-chain  $\alpha$ -keto acid dehydrogenase



**Remember:**  
**vitamins Acts as coenzymes for oxidative decarboxylation**

- Thiamine (B1) → TPP
- Riboflavin (B2) → FAD
- Niacin (B3) → NAD<sup>+</sup>
- Pantothenic acid (B5) → CoASH
- Lipoic acid

# Pantothenic acid (vitamin B5)

## Deficiency Manifestations

- Deficiency of pantothenic acid (CoA) is not well characterized in humans because it is widely distributed in different food sources





# FAD and FMN are the active forms of

- a. Vitamin B3
- b. Vitamin B6
- ☒ c. Vitamin B2
- d. Vitamin C
- e. Vitamin D





# Biotin (B7)

# Case scenario



A 22-year-old body builder has decided to consume **raw eggs** mixed with milk many times/ day in order to increase his muscle mass. After few weeks he suffered from easy fatigability and intolerance for exercise or daily activity. What is the most likely diagnosis?

**Biotin deficiency  
(B7)**

# Biotin (B7)



## Sources:

It is widely distributed in food. It is also synthesized by bacterial flora in excess of requirements

## Functions:



It acts as **CO<sub>2</sub>-carrier** in **CO<sub>2</sub> fixation (carboxylation)** reactions :

- I. Pyruvate carboxylase
- II. Acetyl-CoA carboxylase
- III. Priopionyl CoA carboxylase

So Biotin acts as  
coenzymes for  
carboxylase  
enzymes

# Biotin (B7)



## Deficiency:

Deficiency is unknown, except among people maintained for many months on total parenteral nutrition, and a very small number who eat abnormally **large amounts of raw egg**. Uncooked egg white contains a **heat labile protein (avidin)** which can combine with biotin, preventing its absorption and producing biotin deficiency.

**The main symptoms** :are anorexia, muscle pain, dermatitis, delayed growth, loss of hair (alopecia) , and depression

# Pyruvate carboxylase needs which vitamin for its proper function?



- a. Niacin
- b. Riboflavin
- ☒ c. Biotin
- d. Folic acid
- e. Calcitriol





# vitamin C

# Vitamin C (L-ascorbic acid)

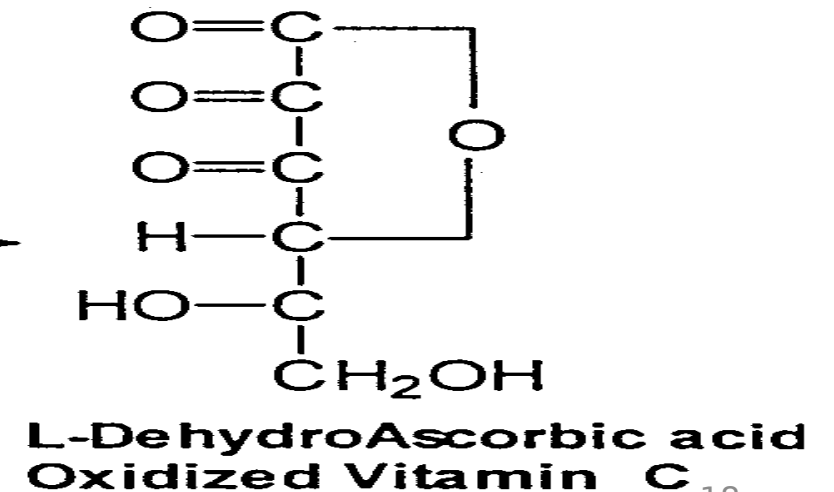
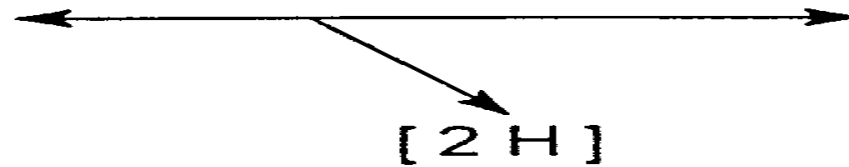
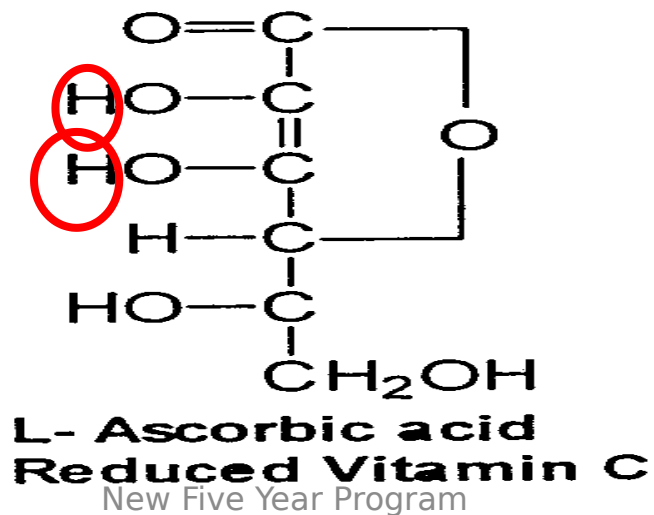


- It is synthesized from glucose by the uronic acid pathway (**not in human**)

- Sources:

**Fresh** fruits and Vegetables

It is **destroyed** by storage of food & **cooking (heat)** & **freezing**





# Functions of vitamin C



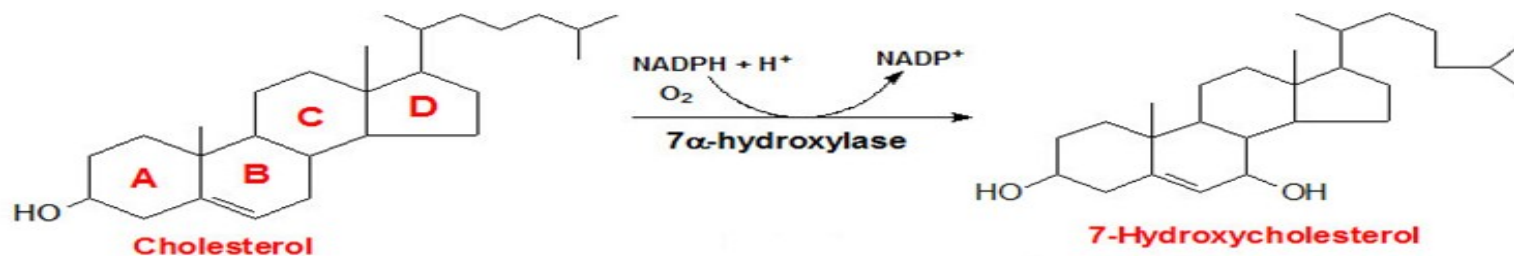
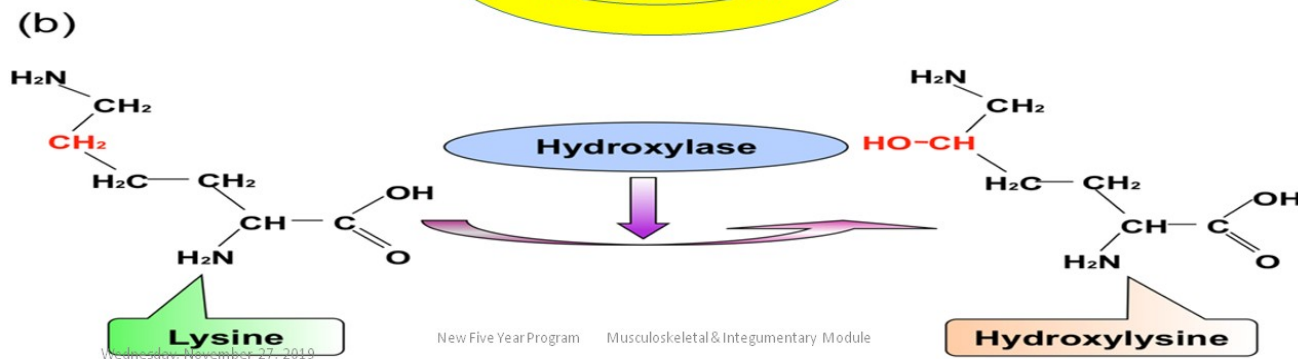
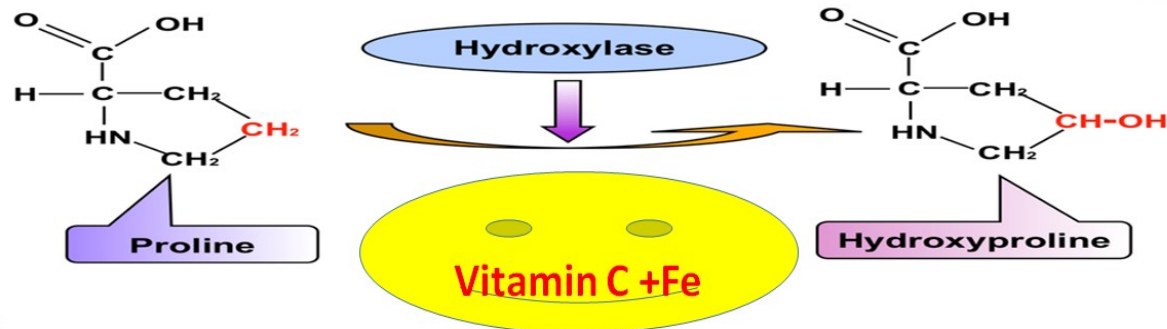
## 1) It is a cofactor for many hydroxylases:

- a. In **collagen synthesis** □ Hydroxylation of proline and lysine □ normal connective tissue (collagen) formation.
- b. Hydroxylation reactions necessary for **corticosteroid synthesis** in suprarenal gland 
- c. **Bile acid formation** (7  $\alpha$ -hydroxylase step).
- d. **Tyrosine metabolism** and synthesis of **norepinephrine** and **epinephrine**

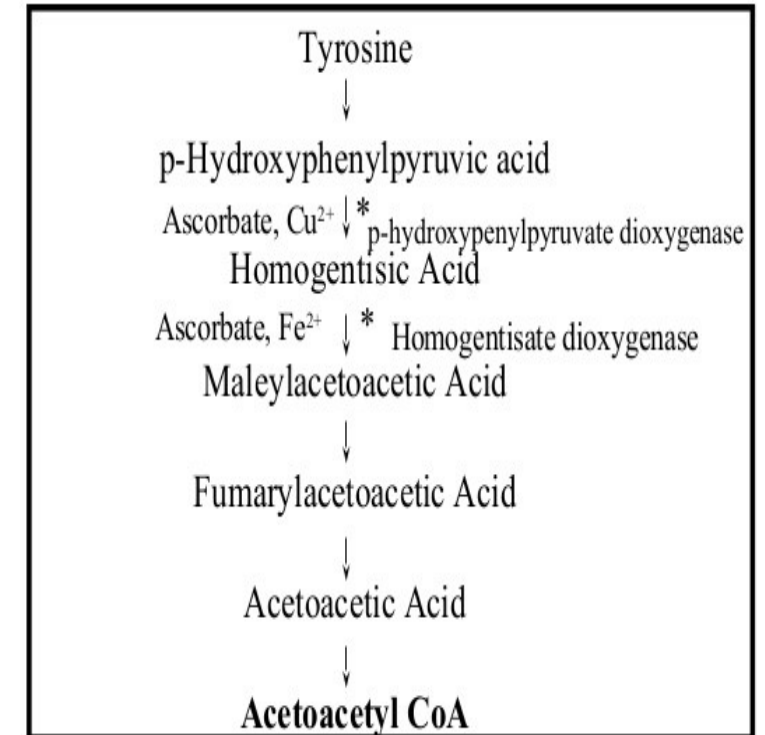
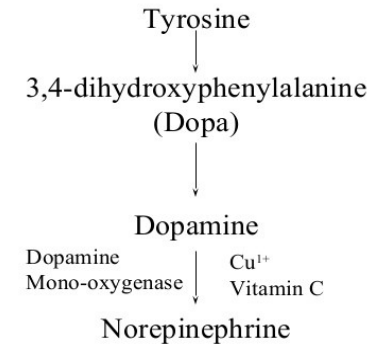
# Functions of vitamin C



## 1) It is a cofactor for many hydroxylase



### Tyrosine Metabolism



# Functions of vitamin C

## 2) Act as a reducing agent (hydrogen donor)

Vitamin C **reduces** ferric ( $\text{Fe}^{+++}$ ) to ferrous ion ( $\text{Fe}^{++}$ ) in stomach and thus **helps absorption of iron**.



## 3) Vitamin C acts as an antioxidant:

Antioxidant vitamins (**vitamins C, E, and  $\beta$ -carotene**)

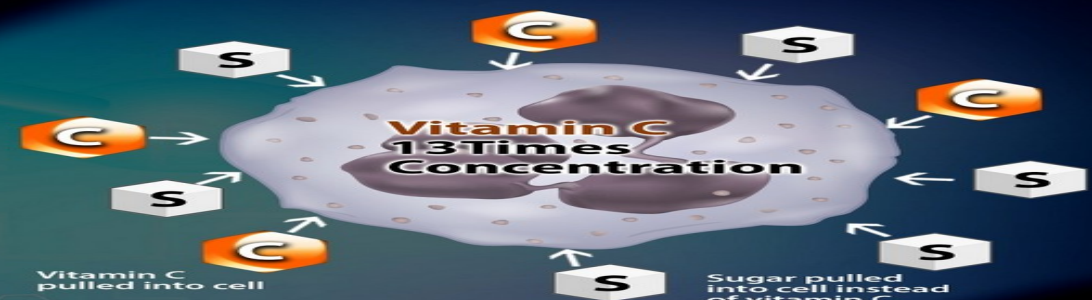
# 4) Immunological function Of vitamin C

Vitamin C could **moderate colds** by :

- **Enhancing many immune cell** (such as some leukocyte) functions and increase phagocytic function □ phagocytosis of virus or bacteria
- **Destroying histamine**, which causes many of cold's symptoms.
- **Increase immunoglobulin's synthesis**



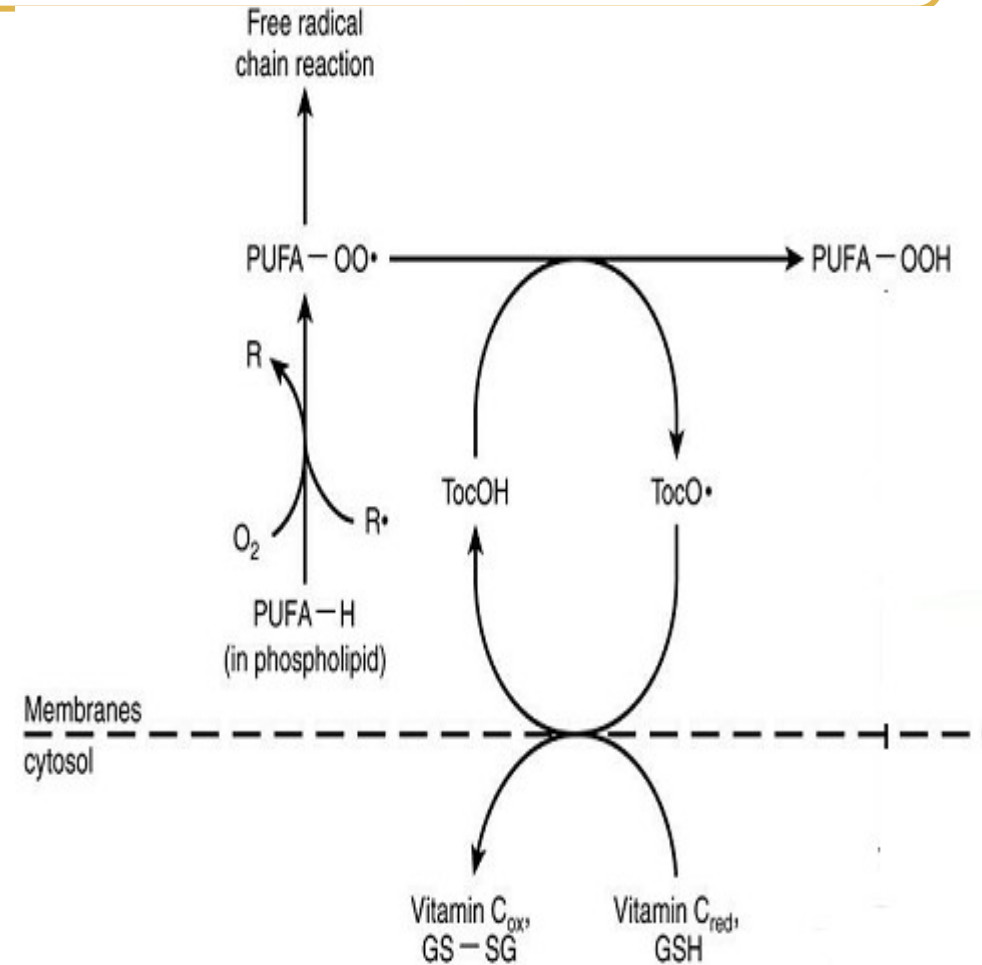
New Five Year Program  
White Blood Cell able to destroy the maximum number of viruses and bacteria.



White Blood Cell can only destroy 25% as many viruses and bacteria.

## 5) Role of vitamin C in prevention of chronic diseases

- **Vitamin C is a highly efficient water soluble antioxidant.**
- **It regenerates the functional, reduced form of vitamin E.**
- **Consumption of diets rich in these vitamins is associated with a decreased incidence of some chronic diseases, such as Diabetes, coronary heart disease and certain cancers.**



# Summary of vitamin C functions



## 1) Cofactor for hydroxylases enzyme (reducing agent in hydroxylation reaction)

- a. In collagen synthesis □ Hydroxylation of proline and lysine □ normal connective tissue (collagen) formation.
- 
- b. Hydroxylation reactions necessary for corticosteroid synthesis in suprarenal gland
- c. Bile acid formation (7  $\alpha$ -hydroxylase step).
- d. Tyrosine metabolism and synthesis of norepinephrine and epinephrine

2) Vitamin C reduces ferric ( $\text{Fe}^{+++}$ ) to ferrous ion ( $\text{Fe}^{++}$ ) in stomach and thus helps absorption of iron.

3) Vitamin C acts as an antioxidant

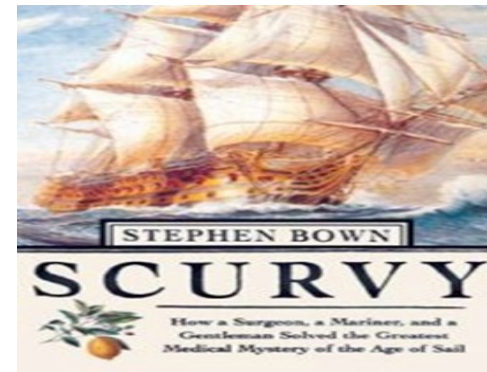
4) Immunological function

5) Prevention of chronic diseases



# Vitamin C Deficiency (scurvy):

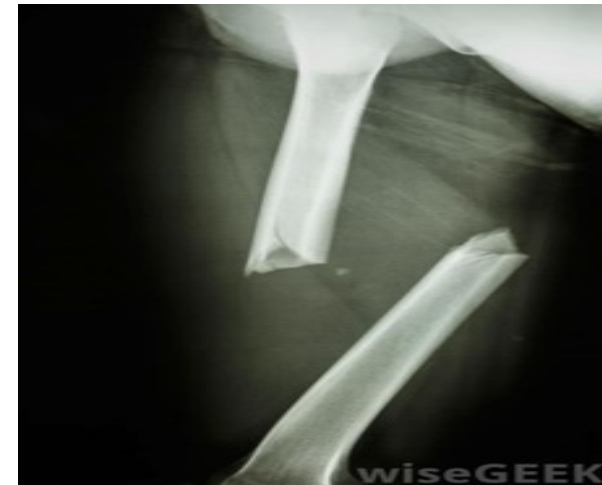
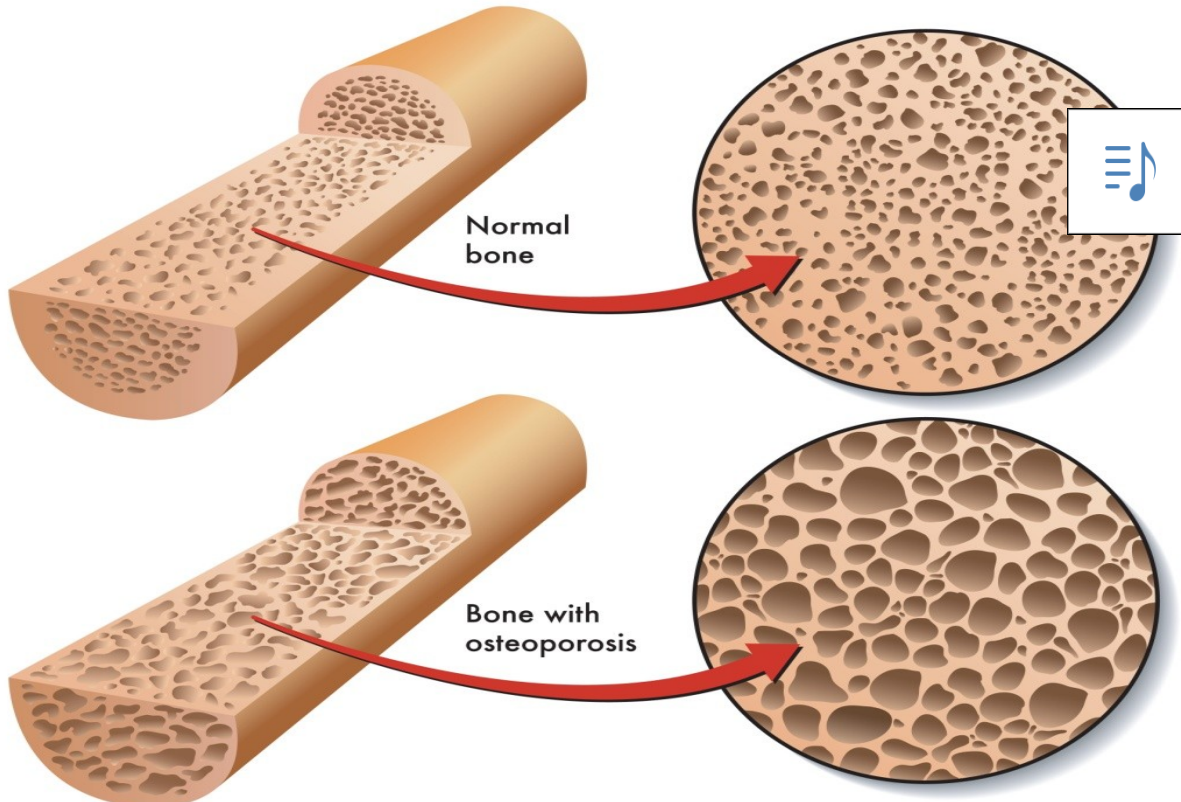
due to decreased fresh fruit and vegetables in diet



## Manifestations :

**[A] Manifestations due to impaired hydroxylation of proline and lysine in collagen**

- (1) **Delayed** wound healing.
- (2) loose teeth & bleeding gums.
- (3) **Swollen joints & Osteoporosis**: due to inability to maintain collagenous matrix of bone → demineralization of bone → easy fracture
- (5) **Easy bruising and subcutaneous hemorrhage** this is due to increase capillary fragility





# [B] Microcytic hypochromic anemia

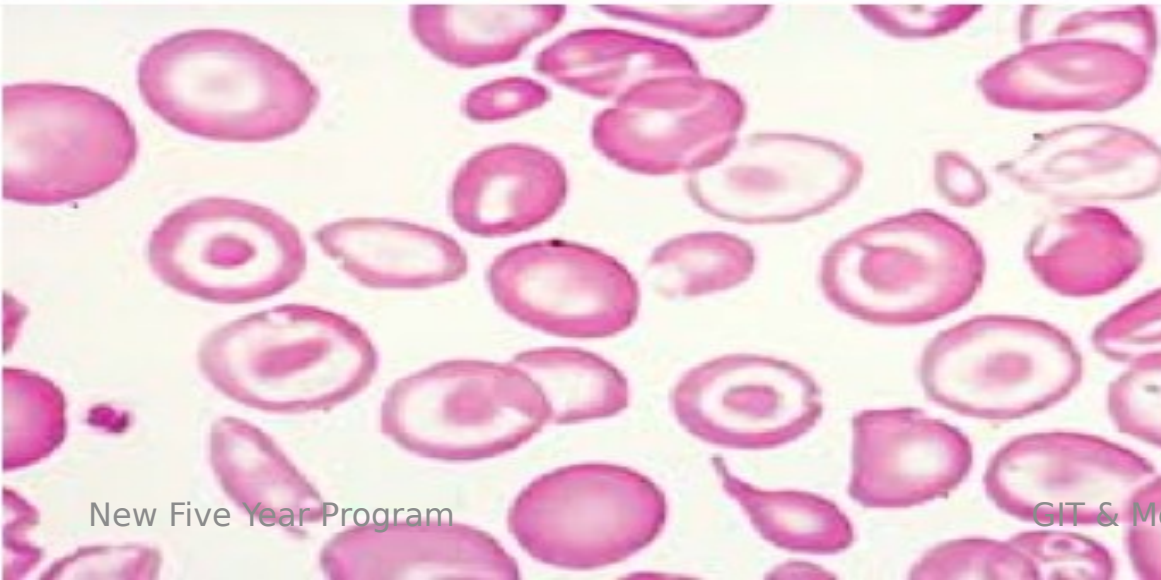
may occur due to:

- **Chronic blood loss**
- **Defective iron absorption.**

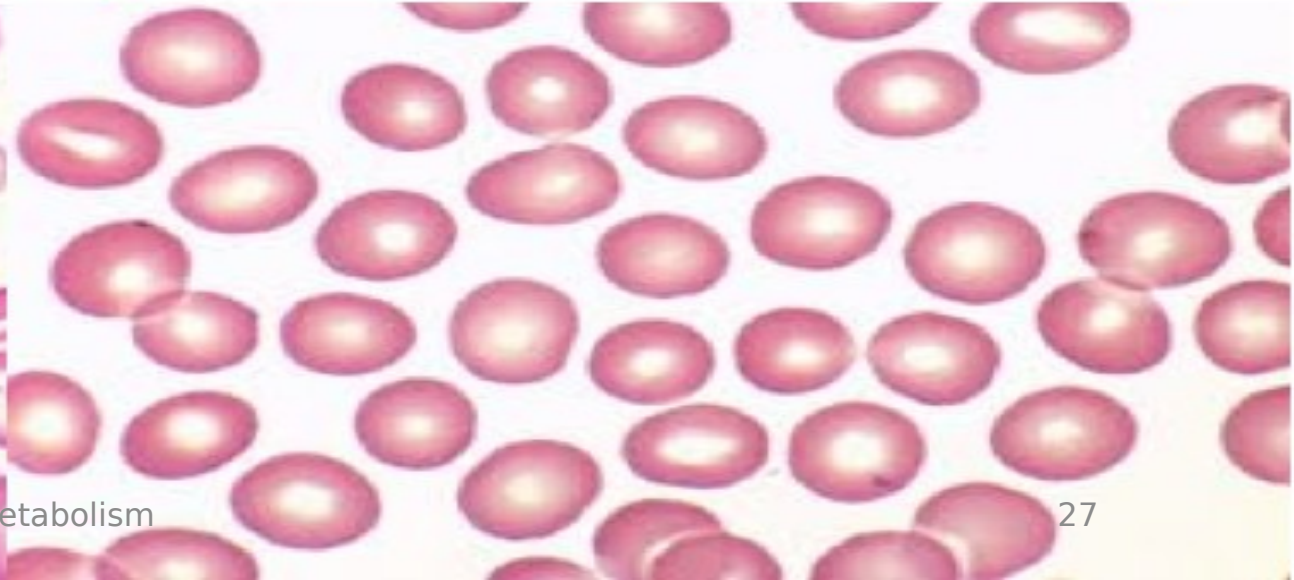
Explain on  
biochemical basis ?



**Microcytic Hypochromic Anemia**



**Normal Blood Smear**



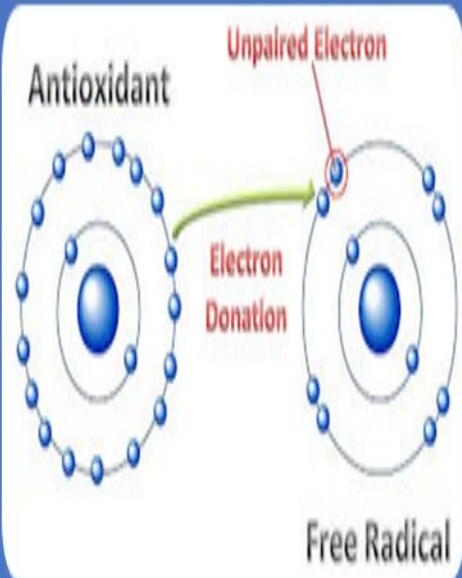
**Patients with scurvy are liable to easy bruising.**



**Give a reason**

**Due to impaired hydroxylation of proline and lysine in collagen.**



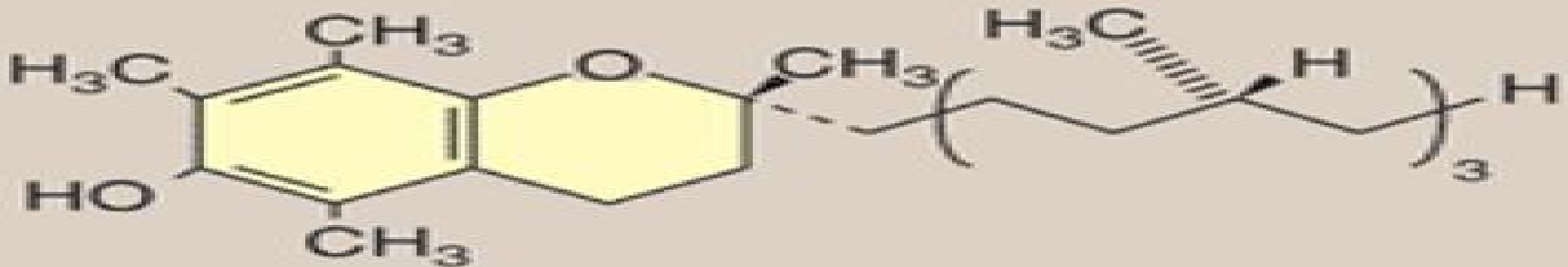


# vitamin E

## Vitamin E (Tocopherol) (Rat Antisterility Vitamin)

# Chemistry:

- It is **fat soluble vitamin**\*.
- **$\alpha$ -tocopherol is the most active form of tocopherols.**



## Sources :

**Vegetable oils** are rich sources  
(wheat germ oil, sunflower oil,  
cotton seed oil, corn oil)



*N.B.*

***Fish liver oil does not contain vit E.***

***Animal sources:***  
egg, muscles, liver  
Milk and fish  
(moderate amount)



Olive Oil



Coconut Oil



Sunflower Oil



Broccoli



Kale



Spinach



Avocado



Almonds



Peanuts



# Vitamin E



## Functions:

**Vitamin E is the most widely distributed antioxidant in nature**

- It tends to concentrate in cell membranes **especially RBCs** and plasma lipoproteins to prevent oxidation and destruction of Polyunsaturated fatty acids. So,  **protects against hemolysis**
- It Prevents destruction of Lung tissue damage by air oxidants.
- Also present in the **surface coat of LDL** where it prevents its oxidation and, thus, it **protects against atherosclerosis and coronary artery diseases.**

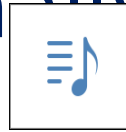


## Deficiency of Vitamin E

### Manifestations:

#### **1- Hemolytic anemia of newborn.**

It occurs in premature infants who are born with inadequate vitamin E reserves. Their erythrocyte membranes are abnormally fragile as a result of peroxidation.



#### **2- Nerve and muscle membrane damage.**



# The most widely distributed antioxidant in nature is:



- a. Vitamin B3
- b. Vitamin E**
- c. Vitamin B2
- d. Vitamin C
- e. Vitamin D





# Newly discovered vitamins (B15, B16)

# Newly discovered vitamins similar compounds



## Pangamic acid (B15)



### ➤ Chemistry:

Pangamic acid (d-gluconic acid + dimethylglyoxal)

### ➤ Main food source:

Firstly isolated from apricot seeds and other food sources

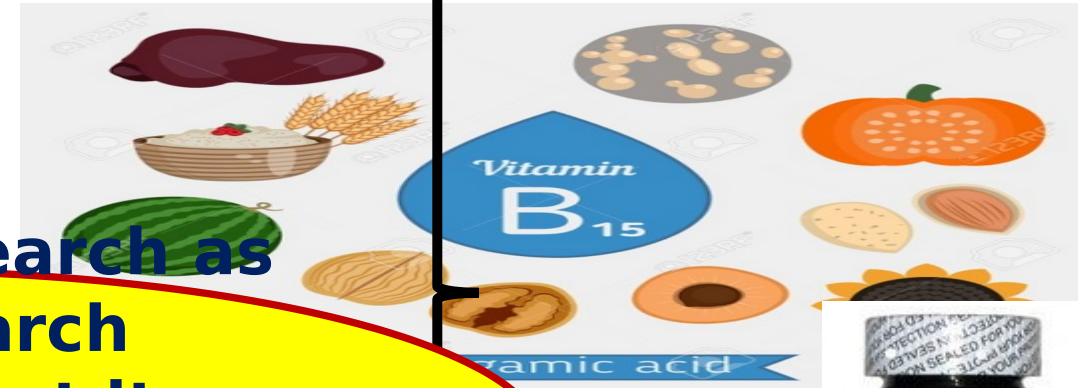
### ➤ Functions:

Due to its ability to denote methyl group it **could be** used in:

- **Detoxification**
- Cancer
- Aging & atherosclerosis
- Heart diseases
- Treatment of asthma
- Skin conditions
- Joint pain
- Nerve pain



Still under research as  
some research  
suggested that its  
**mutagenic** especially if  
mixed with nitrite (food  
additive)



# Newly discovered vitamins similar compounds



## (Dimethylglycine) (B16)



➤ **Chemistry:**  
**dimethylglycine.**

➤ **Main food source:**

naturally in both animal and plant cells and in certain foods including

Liver, beans, cereal grains.

### **.Functions:**

Due to its ability to denote methyl group it **could be** used in:

- **Detoxification**
- **Cancer**
- **Athletic performance enhancer**
- **Immunostimulant,**
- **Treatment for autism,**
- **Epilepsy**

**Still under research**

# Key Points



- **Pantothenic acid (vitamin B5) is widely distributed in food. It forms ACP and CoA-SH. It acts as a lipotropic factor.**
- **Biotin acts as coenzymes for carboxylases. Its deficiency might occur among people on TPN, or who used to eat uncooked eggs.**
- **Vitamin c is a very unstable one. It is important in collagen synthesis, iron absorption and acts as an antioxidant. Its deficiency leads to scurvy.**
- **Vitamin E is the most widely distributed antioxidant in nature.**
- **Vitamins B15, B16 are newly discovered ones. They can denote methyl groups with roles in detoxification, and cancer**

## SUGGESTED TEXTBOOKS



- "Lippincott's Illustrated Reviews in Biochemistry" by P.C.Champe, R.A.Harvey and D.R.Ferrier
- "Harper's Biochemistry" by R.K.Murray, D.K.Granner, P.A. Mayes and V.W.Rodwell.
- Fundamentals of Clinical Chemistry (Tietz) Sixth
- "Textbook of Biochemistry with Clinical Correlations" by T.M.Devlin
- **[www.namrata.co](http://www.namrata.co) - *Biochemistry for medics***



